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ABSTRACT

This report describes the major projects undertaken by the Institute for Policy Analysis of the University of Toronto. It includes a list of the publications that are now available and those that will become available during the next few months. The projects are: (1) Program Planning and Budgeting in Universities; (2) Planning and Financing Higher Education; (3) Models for University Planning; (4) Integrated University Information Systems; (5) Models for Planning and Use of Physical Facilities; and (6) Planning and Management Systems for University Information Resource Centers. They are outlined by: (1) objectives; (2) general project description; and (3) project status as of December 31, 1969. (AF)

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A research progress report on

Systems Analysis for Efficient Resource Allocation in Higher Education

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and
Research Project Director

1 January, 1970.

HE 001 572

1. Introduction

Many people have expressed interest in the work of our Research Program on Systems Analysis for Efficient Resource Allocation in Higher Education. This Program, funded mainly by the Ford Foundation, is a research activity of the Institute for Policy Analysis in the University of Toronto.

The Program began in May, 1968. This brief report describes our major projects and indicates their status at the end of 1969. It also indicates (1) which publications are now available, and (2) which will become available during the next several months. All research results of this project are or will be in the public domain; none are proprietary in any way. It is our objective to publish and disseminate all useful results.

2. Program Planning and Budgeting in Universities

This program has evolved during the year. It began as a project on "Objectives, Success Measurement and Feedback in Higher Educational Systems". The first stage of this project was to review the literature on the subject and to conduct numerous interviews. We concluded that we could best make our work operational by imbedding research on objectives within a project to design and develop a university Program Planning and Budgeting System (PPBS).

2.1. Objectives of this Project

PPBS can substantially contribute to the efficient allocation of resources in higher education. The specific objectives of the PPBS project are:

To develop a conceptual approach to the definition of educational objectives and to indicate how broad objectives may be translated into operational goals.

To develop an educational program structure which will provide a meaningful basis for the planning, budgeting and management of educational resources by focussing upon the basic objectives of higher education.

To develop quantitative measures of program output.

To develop specific systems and procedures for the annual programming and budgeting process and to define the role of decision-makers at various levels in the process.

To integrate CAMPUS planning models and university information systems with the annual programming and budgeting process.

To provide a system for the periodic review of programs in terms of actual and planned results.

To develop procedures and approaches to the introduction of PPB systems to institutions of higher learning.

2.2. General Project Description

The PPBS project has been divided into four main tasks, which are being undertaken in sequential order:

(1) Survey and evaluation of existing planning and budgeting systems in institutions of higher learning in the United States and Canada.

(2) The development of PPB Systems for institutions of higher learning in (a) the Province of Ontario and (b) universities in general.

(3) The development of appropriate methods for the disbursement of public funds to institutions of higher learning.

(4) The study of alternative system designs for post-secondary education in Ontario.

2.3. Status of the Project as of 31 December, 1969

The study of existing planning and budgeting systems has been completed and some preliminary designs of PPB elements such as program structures, PPB cycles and information systems have been developed. A report on this work is available. [26]

The development of PPB procedures for Ontario universities and colleges is presently in progress. Considerable time and effort is being spent on the integration of the CAMPUS planning models and CAMPUS university information systems with the annual programming and budgeting process. A report on the progress of this work will be available soon. [27]

3. Planning and Financing Higher Education

Higher education is expensive. Given any set of social objectives, the main strategic problem is to determine which kinds of higher education should be provided to which members of the population. A second strategic problem is to determine how this education is to be financed. This research project is directed to these questions.

3.1. Objectives of this Project

The objectives of the project on Planning and Financing Higher Education are:

To assess the total and marginal benefits (private and public) of various post-secondary educational programs at various levels of those programs.

To project these estimates of costs and benefits into the future under alternative assumptions about technological change, economic growth, social structure, and educational technology.

To assess the sensitivity of the results to various uncontrollable and stochastic factors.

To explore the costs and benefits of alternative ways of financing higher education in both private and public institutions.

Where otherwise desirable methods of financing higher education appear to be precluded because of political and other constraints, to search for possibilities of relaxing those constraints.

3.2. Status of Research as of 31 December, 1969

Research on this project has a number of facets. Theoretical work is aimed at improving our understanding of the costs and benefits of higher education. On the benefit side, this involves an identification of the social and private goals which are thought to be served by higher education. It involves a study of the reasons for possible divergence of social and private benefits; imperfect knowledge, externalities, public goods, market imperfections, undesirable income distribution, indivisibilities and economies of scale.

A considerable literature recently has developed in the field of "educational planning". A critical survey and evaluation of this literature has been completed and is available. [5] A doctoral thesis on the demand for higher education in Canada is in preparation and a preliminary progress report is available. [19]

The contribution of higher education to income and economic growth is the subject of one series of studies involving the computation of private rates of return on investment in undergraduate and professional education. Reports on this work are available. [20, 21, 22] We are now computing rates of returns for graduate education.

Every kind of public expenditure has an income redistributive effect. We are investigating the income redistributive effect of public aid to higher educational institutions. Early results point to neutral income redistribution by means of public financial aid to those institutions in Canada. A preliminary report on this study is now available. [7]

Substantial effort has been devoted to the study of alternative systems of student financial assistance. Questionnaires were administered to approximately 9,000 Ontario high school students in an attempt to assess (1) student perceptions of the benefits and costs of various forms of post-secondary education and (2) their perceptions of various existing and proposed systems of financial assistance. A simulation model, CORSAP (Contingent Repayment Student Assistance Program), has been constructed to assist the analysis of different

assumptions concerning enrolments, incomes, behaviour patterns, combinations of loans and grants, and other policies. This work, partly funded by the Ontario Department of University Affairs, continues but a report is now available. [23]

The analysis of alternative methods for the disbursement of public funds to institutions of higher learning is also in progress. Initial efforts are concentrated on a study of formula financing schemes and the development of an appropriate financing system for the Ontario Colleges of Applied Arts and Technology. A draft report on the progress of this work is available. [28]

4. Models for University Planning

Previous CAMPUS models were designed and constructed for specific institutions. These models have been critically re-examined in order to improve the method of their construction and to evolve a general CAMPUS system more easily applicable to all classes of higher education institutions.

4.1. Objectives of the Project

To develop a flexible and modular system for generating CAMPUS-type models suitable for adaptation to a broad class of educational institutions.

To develop the framework for a series of alternative configurations of CAMPUS-type models which could be used by specific institutions in implemention.

To develop one complete sample CAMPUS system representing a hypothetical university, which would be used by specific institutions in implementation.

To develop data and parameters for this specific situation in order to demonstrate the applicability of CAMPUS-type models and to run and analyse a series of problems on this "representative" system.

4.2. General Project Description

An attempt has been made to develop a CAMPUS simulation system rather than specific CAMPUS models. In such a system, structural and systems descriptors of an institution would generate a specific CAMPUS simulator which will be representative of that institution. A generalised CAMPUS system should facilitate and shorten the programming effort and lead-time required to produce and implement such a simulation model.

The organisational form, data files and information and budgeting needs vary greatly among different institutions. Because of this, it has been the policy of this research program to concentrate on those aspects of CAMPUS modeling that are common to the broadest class of potential users. In particular, we have concentrated on the detailed development and programming of a generalised core simulator. In the input/output area, where individual institutional idiosyncracies flourish, we have confined our efforts largely to the conceptual design of alternative input and reporting structures. The core simulator is represented in the lower centre of Figure 1 by the heavy circle. Most of the peripheral routines must be customised for each user institution.

4.3. Status of this Project as of 31 December, 1969

4.3.1. Development and use of CAMPUS models in the health sciences

CAMPUS-type models have been developed and implemented in the health science faculties of the University of Toronto. Final documentation of these models is now nearly complete; all reports on model design and use are now or shortly will be available. [6]

4.3.2. Development of the CAMPUS–V core simulator

Development of the CAMPUS–V core simulator is finished. It is a generalised computer program

POSSIBLE CAMPUS SYSTEM CONFIGURATIONS

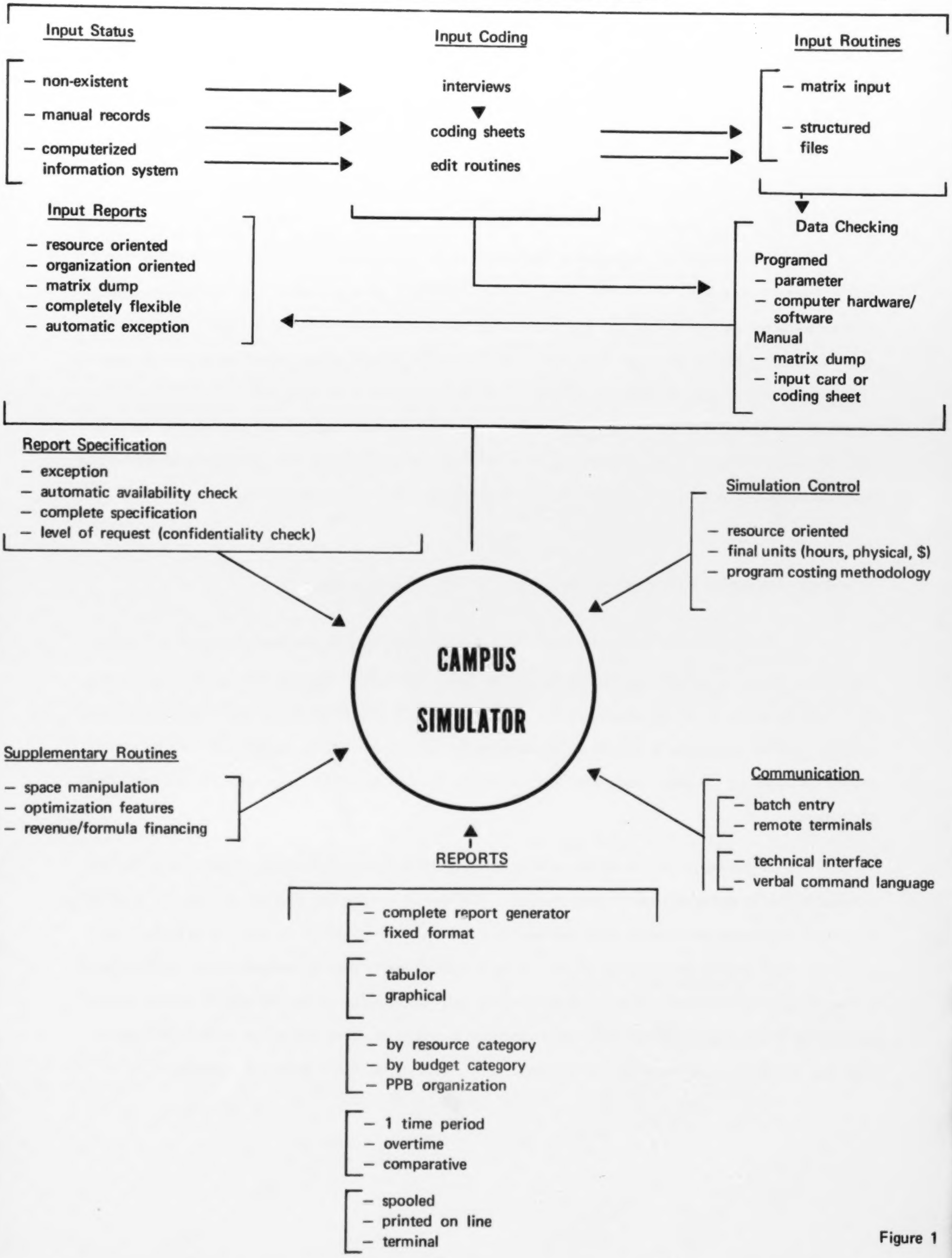

Figure 1

capable of simulating a large class of educational institutions. Programmed in FORTRAN–IV, it is operational on an IBM 360/65 computer. Many people have requested the documentation of CAMPUS–V. To accomodate model designers elsewhere, we are now releasing the CAMPUS–V documentation. This consists of a program listing, flowcharts and identification of variable and array names. [2] This material is intended for the technically sophisticated; it is not a piece of "off-the shelf" software that can be used without careful adaption to the specific circumstances of the user institution. CAMPUS–V is operational and now being used by a number of North American educational institutions, and implementational efforts are beginning in more than twenty universities and community colleges. Although CAMPUS–V is not expensive to implement, user institutions lacking internal technical expertise are advised to seek it externally before proceeding with implementation.

4.3.3. Development of alternative designs for CAMPUS simulator support

The core simulator must be supported by input/output routines specifically designed for individual institutions. It is not an objective of this project to design and build a comprehensive set of these routines. We do aim, however, to set out the alternatives. This should enable universities and colleges interested in implementing CAMPUS techniques to build a set of input/output routines that will be applicable to their institutions. Project personnel are involved closely with the Information Systems and PPBS project staffs in designing these alternatives.

On the input side this involves setting up procedures which could vary from editing existing machine-processable files to gathering required data manually. The output or reporting structure will depend upon the institution's organisational structure and how administrators wish the model to be used. Interactive routines might vary from manual manipulation of input cards to sophisticated computer routines which would respond to English language commands. Communication with a CAMPUS planning system will depend on the size and composition of the support group. This could vary from a central group of technicians working directly on a large scale computer to non-technical administrators communicating through a system of terminals.

Over the next year project personnel aim to describe a set of alternative configurations which will be amenable to the general CAMPUS structure. A particular subset will be programmed as a "representative" system at a "representative" institution. Figure 1 is a preliminary schematic of some of the alternatives.

A number of analyses and experiments will be performed with the CAMPUS–V model. A hypothetical but realistic university data set has been "created" and is being modified by supplying realistic parameter estimates to the variables of the model. Experiments are being conducted in order to study problems such as economies of scale, academic phase (e.g., semester vs. quarter), curriculum design, academic staffing policy, space utilisation policies, use of alternative teaching media (e.g., TV, CAI and others). Publication of the results of these experiments in 1970 will provide an insight into the economics of academic institutions that is unavailable and probably unobtainable by means of conventional empirical studies. This test system, as well as working as an experimental tool, will be an aid in familiarising administrators with university management principles and in the use of interactive computer facilities.

5. Integrated University Information Systems

In a fundamental sense, the problem of designing better management tools for university administrators is one of developing information systems. Decisions on academic planning, programming and budgeting require information and analyses about program inputs and outputs. CAMPUS-type simulation models require data on a variety of topics.

5.1. Objectives of this Project

To determine the information demands of university management and operations.

To design integrated information systems to economically supply the proper quantity and quality of information to university decision-makers and administrators.

To plan the rational use of computers to meet university information requirements.

5.2. General Project Description

The first stage of the project has been a familiarisation with the University of Toronto from the standpoint of organising the concepts fundamental to formulating an overall design. This entailed identification of several decision levels at the University as well as documentation of the decisions made at each level, the sources of information, its flows, its stores and sinks.

The second stage involved an analysis of the results of the first stage to produce a list of data elements required to be contained in the system files for the generation of management information and also to provide the data required by the CAMPUS model. This involved considerations of standard file format and definition of a "workable" data set and a "maximum" data set.

The third stage is to design and document the logical structuring of the sub-systems embodied in a university, such as registration, payroll, etc., in a manner which makes them compatible and interactive, so that information is shared and utilised throughout the system. This should tend to minimise duplication of data and eliminate or minimise redundant functions.

The final result of this project will be a standard integrated management information system linking to a CAMPUS-type resource implication model. Ideally, the system could be implemented at a university with little or no modification.

5.3. Status of this Project as of 31 December, 1969

Work on this project is progressing in the following areas:

5.3.1. General description of decision-making information needs in the University of Toronto

Work in this area has been oriented towards producing accurate representation of the informational flows at the University of Toronto, the decisions that are made and the impact that these decisions have on the operations of the institution.

The overall aims are (1) to represent the university as an information network which represents the integrated information requirements of the university to carry on the decision process and (2) to improve these wherever possible.

The documentation consists of "decision tables" and "network graphs". Work on the decision tables is complete for all levels of the university while the network graphs remain to be extended beyond their present faculty level. [32] Present work in this area consists of completing the network graphs and integrating all the areas of documentation into a document which will reflect the integration required within the information system to provide management with complete information.

5.3.2. Data base

Work on the data base is progressing in five areas, namely:

(a) Students – Work in the student area consists of a comprehensive data set as well as a minimum data set which was generated through a survey of the records maintained at Ontario universities.

(b) Staff – In the staff area, a comprehensive data set has been generated and a study is contemplated to produce a minimum data set.

(c) Space – Some sections of the comprehensive data set for space have been completed, namely Buildings, Rooms, and Room Fixed Equipment, and the file will be extended to include other relevant categories shortly.

(d) Program – At present the data set for describing programs has been generated and a first attempt at defining program categories is anticipated shortly.

(e) Finance – A data set for describing assets, liabilities, expenses and incomes has been generated as well as a first attempt at standardising each of these categories. Some work has also gone into the conceptual design of the coding structure which is required to reflect and incorporate the requirements of a PPB system.

Reports should be available by 1 May, 1970.

5.3.3. Output reports

At present, output reports have been designed in the student and space areas for all levels of the university. These are in the process of being revised and integrated closely with PPBS and CAMPUS model reports.

5.3.4. File maintenance software

The effort in the software area consists of a liaison with the Ford Foundation supported Stanford Project "INFO" as well as a minor independent effort to accumulate information on commercially available file maintenance systems. No development effort is anticipated in this area at this time.

A survey has been made of existing software "packages" which seem capable of performing file maintenance operations compatible with our requirements. Evaluation is now in progress. A documentation package has been prepared so that the format of each evaluation will be standardised for all packages and it is planned that a standard procedure will be generated for on-site operational evaluation of the capabilities of selected packages. Competent evaluations done by other individuals or organisations will be incorporated into the documentation wherever possible.

5.3.5. System documentation

A documentation manual has recently been completed which outlines the format of documenting each of the sub-systems of the project. This will standardise documentation and provide several levels of detail, beginning with the most general and ending with the most particular. Work on documentation of the student system has been underway and preliminary documentation has been completed.

6. Models for Planning and Use of Physical Facilities

The costs and benefits of providing physical plant depend upon various social and economic factors. Administrators, architects and academics need information about the requirements of present and potential users and about the cost of various alternatives.

6.1. Objectives of this Project

To develop qualitative and quantitative measures for evaluating the performance of a present or planned building.

To develop input and output formats to assist visual inspection and encourage experimentation.

To provide a medium for the generation of alternatives in design, to gather and store opinions on these alternatives, and finally to evaluate feasible sets of alternatives.

6.2. Status of Research as of 31 December, 1969

A model has been developed to allocate rooms into a "three dimensional corridor grid". The objective function is the cumulative corridor width resulting from traffic between rooms. Principal constraints are that the amount of space available at any point in the system exists and that necessary widths for fire exits are maintained.

The locational problem has traditionally been a major task of the architect and planner and a rapid mathematical evaluation of alternatives facilitates studies in the areas of social communication and the flow of goods in related networks (for example, air conditioning lines). Documentation of this model will be available by 1 May, 1970. [1]

A model has been developed to optimally match "rooms required" and "rooms available" using as an objective function the amount of existing space consumed and the amount of space that must be built to

satisfy otherwise unsatisfiable needs. Existing spaces that are superfluous are shown as such – potentially removeable. Further development will include (1) cost-centre affiliation, (2) locational criteria, (3) large scale models, and (4) the inclusion of a method for including renovation in the process.

A model has been developed to analyse individual and group opinions (good, indifferent, bad) about alternatives or goals concerned with building project development, or of a policy area in general. Statistical measures are being developed to represent the relative importance, variance in opinion, relationship to other goals, and conflict with other goals. Questionnaire techniques are being tested in which each respondent distributes a number of hypothetical dollars or points among the precosted alternatives or goals. The objective is to synthesise the most feasible sets of alternatives and to determine contentious goals or alternatives for clarification or further discussion. A preliminary version of this model is working.

A library of mathematical models related to architectural programming, particularly in the areas of factor analysis, cluster analysis and allocation techniques is now being built. A report on these models will be available by 1 June, 1970.

7. Planning and Management Systems for University Information Resource Centres

A strong information resource is central to the success of programs of higher education. Information must be readily available to the user. This project aims to draw together standards and existing management techniques and to add systems of cost modeling, performance evaluation and benefit analysis.

7.1. Objectives of the Project

1. To isolate and specify the outputs of the library and to explore means of quantifying these.
2. To provide techniques of determining the costs and evaluating the performance of the academic information centre.
3. To integrate the planning and management of the university information resource centre with the university as a whole.
4. To evaluate existing library standards and management techniques.

7.2. General Project Description

COSTLI is a cost estimating model designed to provide data on the costs of providing various types of library services. Projections of user population and library system design are incorporated into the model as data.

CRITIC is a method of assessing the performance of libraries and information resource centres. It uses goal-alternative evaluation and standards of comparison. CRITIC also borrows from existing standards and evaluation techniques.

A Program Planning and Budgeting system will be devised for university I.R.Cs. This will include definition of goals, programs, and review cycles. Within this project the programs of the I.R.C. will be related to the programs of the university.

An assessment of the state of the art of library science/information science will be made.

7.3. Status of Project as of 31 December, 1969

COSTLI is operating. Tests are being performed and modifications made. A simple estimate of the costs of providing specific library service for the universities of Ontario has been prepared. Documentation of the initial version of this model is available. [16]

A goal-alternative model is being developed in conjunction with the Planning and Use of Physical Facilities project. A study of existing library standards has been initiated.

A cycle for evaluating performance has been designed based on COSTLI and CRITIC. After analysing the organisational structure of several library systems, a program-related organisational structure has been designed. A series of questionnaires has been circulated to selected library managers in order to identify intra- and extra-library information flows. This study is being undertaken in cooperation with the Integrated University Information System project.

A study of the literature and of several libraries has been carried out in order to provide familiarity with the operations of university libraries. The accumulation of such literature and reports form a basis for a state of the art report.

A study of alternative future configurations of information resource centres for post-secondary education in Ontario is now in progress.

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	UGEDUC: Program Documentation No. 1	Doc. No. 30	$ 2.00
	Appendix A. Run Operating Instructions Appendix B. Proposed Changes and Modifications Appendix C. Subroutines Flowcharts and Methods used.	Doc. No. 31	$ 2.00
	Appendix D. Sample Listing of Input (case 130) Appendix E. Sample Output (case 130) Appendix F. Program Listings Appendix G. Activity Deck No. 6 Listing Appendix H. Curriculum Deck No. 14 Listing.	Doc. No. 32	$ 5.00

		Document Number	Price
[6] cont.	UGEDUC: Program Documentation No. 2 RGP	Doc. No. 33	$ 2.00
	Appendix A. Run Operating Instructions Appendix B. Suggested Modifications Report Table Manipulations Appendix C. Methods Used, Flowcharts Appendix D. Input Data for UGEDUC RGP (case 130)	Doc. No. 34	$ 1.00
	Appendix E. Selected UGEDUC RGP Output for case 130 Appendix F. Program Listing. (computer output)	Doc. No. 35	$20.00
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		Document Number	Price
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